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Research management is defined as the application of both management and management science to a particular field of research and development activities. Seven components of research management include theory and methodology; the planning, implementation, and evaluation of research programs; communications; utilization; and special applications. Three general approaches to the study of R and D management focus on behavioral, economic, and operational concerns. Major problem areas include methods of measuring the effectivenss of R and D organizations, the optimum connection of R and D with production and marketing, and dissemination of research findings. Study programs to prepare R and D managers for creative leadership are suggested. A bibliography of 78 items published between 1957 and 1969 is appended. (JK)

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Preliminary draft of a paper prepared for the American Educational Research Association Special Interest Group on Research Management. Comments and suggestions regarding the paper should be forwarded to the author.

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Introduction

At the 1969 annual meeting of the American Educational Research Association in Los Angeles, a Special Interest Group in the area of Research Management was formulated in accordance with the policies and procedures set forth by the parent organization. The initiators of this Special Interest Group were Dr. Howard Hjelm of the U. S. Office of Education and Dr. Harold Mitzel of Pennsylvania State University. A preliminary meeting had been held at the 1968 meeting in Chicago to explore any possible interest among the AERA membership in forming a group concerned with the administration of research activities. The meeting in Los Angeles resulted in the formal establishment of the special interest group under the AERA structure.

During the course of the meeting, the author of this paper was elected as chairman of the group. Discussion as to the objectives and possible activities of the Special Interest Group plus action taken to change the title from Research Administration to Research Management resulted in questions being raised regarding the nature of research management. It was suggested that the chairman prepare a position paper to outline the general nature of the concept for distribution to the membership for further elaboration, clarification, and discussion.

It had been suggested that a paper developed by the author and presented at The Institute of Management Sciences meeting held in Cleveland and entitled "An Overview of Management Science of Educational Research" might be revised to respond to the above charge. Upon giving some thought to this matter the

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author believes that perhaps a different paper might be more suitable as a response to the desired charge. The purpose of this paper therefore is to outline, albeit briefly, some conceptualizations regarding the area of research management which can provide a focus for the membership plus provide a base from which further discussion and actions might be possible.

In preparing the remarks contained in this paper, recognition was given to the fact that the initial membership consisted of a group of individuals with a heterogeneous background. Some are highly concerned with the administration of research within university and college structures, others within local public school districts, and still others at state and national levels. Some individuals were concerned with the administration of research in terms of national programs supported by federal governments while others were concerned about this topic from the point of view of their having administrative responsibility for a particular project or program. It is not altogether easy to deal with such diversity within one paper so only the major conceptions as derived largely from the author's experiences and readings in this area during the past several years can be presented.

A Conceptualization of Research Management

From the author's point of view, Research Management consists of the application of both management and management sciences to the field of research and development activities in a particular area. Management is defined here in terms of the generalized management functions of planning, organizing, directing and controlling. Management sciences is defined to refer the application of scientific and quantitative methods to management decision-making and includes such topics as linear programming, systems analysis, Monte Carlo methods, cueing theory, simulation, operations research, and similar techniques.

Research is defined here to include the generally recognized topic of basic and applied research, however, these terms may be defined by a particular individual. The author does sincerely believe. however, that one must not only be concerned with research as defined above but also must include the interactive concepts of development and reduction to public practice. To talk about research without talking about the other two concepts is to maintain a categorization which is inappropriate to reality. In fact, two authors (29) point up that research management is highly involved with the interfaces between research and development and between development and reduction of public practice. Under this conception, the job of the research manager is to make sure that these interfaces are facilitated.

It has been the author's experience that there is no one single publication to which one can turn for further elaboration of the term research management. Publications by Jackson and Spurlock (34), Gideonse (26), Cole (19), Roman (60), Pons (49), and Yovits (54) are among those which the author has found useful. Additional references are presented in the bibliography included as part of this paper. I am sure that there are other references which might be included in this list since the list was not meant to be exhaustive. Perhaps one activity of the membership might be to compile an annotated bibliography on research management and/or administration, particularly of those items relevant to education.

A Structure of Research Management

The above generalized conception does not fully answer the initial question or provide a sufficient outline of the nature of research management. One could well ask what kinds of things would one be involved in? What kind

of activities would go on under this concept and similar kinds of questions. Perhaps such questions can best be answered by utilizing a suggested structure of the research and development management area presented by Yovits (78) in 1965. In his paper, Yovits identified and outlined seven suggested components of the R and D Management area. The seven components are presented in general below with an extended outline of each being included as Appendix A to this paper.

1. General theory and methodology (The general concern of this component would be on the principles and procedures of R and D Management.)
2. Planning of Research Programs (This topic would be concerned with the stradegy of matching resources with objectives.)
3. Implementation of Research Programs (This topic would be concerned with the execution of plans.)
4. Evaluation of Research Programs and Management (This topic would be concerned with measurement of effectiveness.)
5. Communication (This topic would be concerned with the transmission of research program information.)
6. Utilization (This topic would be concerned with the transformation of results into user applications and research opportunities.)
7. Special Applications (This topic would be concerned with the special problems as they relate to management applications in the science areas.)

A review of the detailed outline above components in Appendix A will point up that each topic has a great diversity of concerns and suggests many possible areas of exploitation for research activities among the membership of the special interest group.

Approaches to the Study of R and D Management

During the past several years, a great deal of interest has been generated with regard to studying the research management process or as it is commonly called doing "research-on-research." As an example of this activity Al Rubinstein at Northwestern University (62) has created a Center processing a programmatic effort on this topic. The Center issues a periodic summary of research being conducted within industry, government and military on the topic of research management. The type of research emphasis or interest that is carried on under such general programs can best be summarized by citing the approaches to the problem that have been identified by Roman (60). He suggests or identified three general approaches, namely behavior, economics, and operations.

Studies on the behavioral dimension of R and D Management would be similar to that carried out by Pelz and Andrews (48) in their investigation of the role of sciences tests in organizations. The chief concern in this general area is upon the personal and personnel problems which are created and/or developed within the structure of research and development organizations or the influence of federal funding upon individual researcher goals and activities.

The economics approach stresses the allocation of resources at all levels (national, local, state) to the research and development effort. Particular concern in this area is with the process of decision-making. Such papers as those by Beckler (12), Brayfield (15), Brooks (16) would be relevant to this area. The chief concern would be primarily with how one sets policies and makes decisions with regard to the allocation of resources within organizational structures to support research and development activities.

The operations approach focuses upon the operational or process dimensions of research and development. Interestingly, Roman points out that this is

perhaps the most neglected dimension of the three approaches. Recent publications by Andrew (5), Glatt (27), Greenberg (30), Nissan (45) and Randall (52) would be examples of work in this area. The chief concern here is with a variety of topics including project selection, proposal rating, organizational structures, and similar topics which might take too long to list in this paper. Much of the author's own work has been in this particular area.

As with most catagorizations, the ones presented above certainly are not mutually exclusive but are suggestive of the kinds of approaches which have been used by others both within and without education to study the management problems associated with R and D.

Some Priority Problems

While the structure provided by Yovits and the approaches identified by Roman would be helpful in discussing what the membership might proceed to do, it would seem prudent for the organization to identify some central issues and move to deal with them. Unfortunately, no such list of essential issues exists for the field of educational research and development management. Perhaps the development of such a list might be undertaken rather rapidly as a group activity. There is available a summary of major problems developed by those persons concerned with the management of research and development within the industrial-government-military complex. Their list of problems might be of value to stimulate discussion on this topic within the field of education. Listed below are the several major areas developed by the recent Industrial Relations Institute Research-on-Research Workshop (74). Only the major topics are listed below. Attached as Appendix B to this paper is an

extended list of questions under each of the major topics.

1. Manpower
2. Education and training
3. Organization
4. Planning and management
5. Behavioral and interpersonal
6. Public policy for Science and Technology

After deriving the above list of problem areas, workshop participants and representatives from IRI were ask to identify major priority problem areas. The five priority problems or questions were ummarized by Williamson (75) as follows.

1. Can the effectiveness of R and D organizations be compared? Can an organization "achievement test" be devised? What qualities are essential in comparative evaluation?
2. How is the optimum linking of R and D to production and marketing achieved?
3. How are corporate or government R and D goals or objectives established? What factors are involved? Who initiates? Who approves?
4. How can information be best "forced" through the "interfaces" that exists both within R and D organizations and between the organization and outside?
5. What programs of study, if any, best prepare R and D managers for creative and imaginative leadership.

One interesting observation can be made with regard to the problems outlined in the IRI workshop paper and the above questions. It would appear that with as much experience that the government-industrial-military complex has had with R and D, knowledge about solutions for these problems is not readily available. The same kinds of questions are being asked in other sectors of the economy as are currently being asked in the field of education. While there are some

differences between education and the other sectors although no one has done an explicit study to state these differences which in itself is a provocative suggestion, it is the author's feeling that we can learn much from what has been done in other areas. We do not proceed to have to "reinvent the wheel."

Summary

The purpose of this paper has been to respond to a charge given the author in his role as chairman of the AERA Special Interest Group on Research Management to provide the membership with a conception of the area. An attempt was made to provide such a conception based upon the possible roles that both management and the management sciences might play in the research area. In order to make the conception meaningful it is necessary to include also the development and reduction to public practice areas. A possible structuring of the R and D management area along with the generalized approaches to studying the problems in this area which focus upon behavioral, economics, and operations concerns was presented. The paper was concluded by outlining some of the problems which have been identified in non-educational sectors as a possible source of ideas for stimulating a program of "research-on-research" within the field of education.

It might be appropriate to summarize both the membership interests and concerns and this paper by providing the following quotation from Morgenstern, Shepard, and Grabowski (43).

> It is indeed true that in the last decade and a half, organized research has undergone an explosive development and that the welfare and security of our nation is increasingly dependent upon the proper management and planning of our research activities. Management of research remains, however, a task of extraordinary complexity. It is essentially an unstructured problem, dealt with largely on an ad hoc basis.

> The problem of research management is not new. Everyone in control of some funds and facilities for research has encountered it, given thought to the problem, and had to make decisions as best he could. These ad hoc decisions lack the firm foundations of a theory form which rules of behavior could be derived.

It would be further appropriate to state that the fundamental goal of the membership might well be the development of a theory and practice of educational research and development management so that decisions will not have to be made on an <u>ad hoc</u> basis.

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Appendix A

Suggested Components of R and D Management Areas

1. General Theory and Methodology (Principles and Procedures).

   a. Relations of research and systems and management processes.

   b. Differences between general-management and research-management theory and practice.

   c. Taxonomy of forms of research as they relate to guidelines and criteria for planning, directing, and evaluating research.

   d. Methods of establishing guidelines for long-range science planning and for program development, including technological projections.

   e. Comparative research-management organizational structures - among various groups and nations.

   f. Concepts and hypotheses toward a general theory of research management.

2. Planning of Research Programs (Strategy of Matching Resources with Objectives).

   a. Nature and functions of research planning - current practices and theoretical alternatives.

   b. Information requirements for research planning.

   c. Nature of a "balanced program" of research in a given discipline or area of research.

   d. Effectiveness of various modes of funding research effort: contracting, grants, in-house staff, in-house contracting, managerial contracting, and others.

   e. Budgeting, finance, and accounting techniques and problems.

   f. Research-management personnel - education, selection, training, compensation, and evaluation.

3. Implementation of Research Program (Execution of Plans).

   a. Coordination of research implications with potential applications.

   b. Allocation of resources - funds, personnel, space, equipment, information - for optimum scientific performance.

c. Coordination of diverse agencies, disciplines, and personnel toward acceleration of scientific progress within given areas of inquiry.

d. Regulation of supervision for the encouragement of creativity and productivity.

e. Equilibration of conflicting missions, objectives, plans, and progress in a large-scale research activity.

f. Current policies and emphases in the management of research - government, industry, foundations, universities, and professional associations.

4. Evaluation of Research Programs and Management (Measurement of Effectiveness).

a. Measurement and data acquisition of qualitative effectiveness criteria.

b. Output evaluation - theoretical advances, utilization rates, and development of effectiveness criteria.

c. Measurement of originality in research.

d. Adaptability of cost-effectiveness concepts to the management of basic and applied research.

e. Evaluation of contractors and proposals.

f. Evaluation of research-management processes, including overall program effectiveness.

5. Communication (Transmission of Research-Program Information).

a. Classification of types of research information for use among management personnel of various backgrounds and positions in the organizational hierarchy.

b. Problems of information dissemination and utilization.

c. Reporting of program results to funders, scientists, and the general public.

d. Information storage and retrieval problems at the program-management level.

e. Information flow and growth at conferences, seminars, planning meetings, symposia, or other organized communication settings.

f. Historical accounts of the missions, objectives, programs, content and effectiveness of research programs.

6. Utilization (Transformation of Results into User Applications and Research Opportunities).

   a. Improving the volume, rate, and quality of research productivity and utilization.

   b. Deriving implications of basic and applied research innovations for user requirements.

   c. Cataloguing advanced user-system concepts.

   d. Analysis and reduction of theoretical, technological, and operational barriers to increased research utilization.

   e. Counteracting utilization problems caused by isolation, segregation, and proliferation of output and personnel in science and technology.

   f. Analysis of specialized or unique research-utilization problems of the physical engineering, environmental, mathematical, and life sciences.

7. Special Applications (Selected Design Needs).

   a. Designing programmatic information and displays for various levels of the management structure.

   b. Identification of theoretical gaps in basic science and the establishment of desirable priorities and levels of effort toward filling them.

   c. Applicability of critical-path scheduling to scientific problems.

   d. Forecasting theoretical developments, program costs, and progress in basic sciences.

   e. Ascertaining breakthroughs, saturation, exhaustion, and other program characteristics.

   f. Innovations in technical and scientific reporting.

Appendix B

List of Topics for Research-on-Research

1. Manpower

   A. What are the career satisfactions and dissatisfactions contributing to the availability of R & D oriented manpower? How can the challenge of a career in R & D best be portrayed in order to attract able manpower into R & D (government, industry, and universities)?

   B. What plans should be developed to assure the needed future supply of workers at all levels (scientists, engineers, technicians, and craftsmen)? What is the optimum manpower mix for the future? Could interchangeability alleviate shortages?

2. Education and Training

   A. What is the optimum education and experience pattern for effective R & D workers? Is this being provided now, or will this require revision of university-industry and university-government relationships vis-a-vis the preparation of R & D career aspirants? (Work-study programs, indoctrination courses, etc.)

   B. If the essential characteristic of modern technology and modern society is change, how can R & D personnel (including managers) be best prepared not only to live with, but actively to plan for and to introduce change?

   C. If creativity, inventiveness, and unconventional thinking are desirable traits in R & D personnel, what programs of education and training will best produce these people?

   D. What programs of study, if any, best prepare R & D managers for creative and imaginative leadership? Does this constitute superior leadership for R & D? How can "internal" enterpreneurs be developed and retained?

   E. How can continuing education best be planned, and how can this best be related to individual and organizational needs? Subjects studied may be technical or non-technical. What is the optimum mix?

3. Organization

   A. What are the optimum compositions of R & D organization units (functional sections, project teams, etc.)? That is, the optimum mixtures of age, experience, levels of education, formal fields of study, etc.?

B. How is size of organizational units related to optimum performance? Does this depend upon style of leadership, nature of the task (research or development), etc.?

C. How is productivity and innovation affected by the age of the R & D organization or laboratory? What factors are pertinent (routinized procedure, red tape, long-established friendships, informal cliques, etc.)?

D. How is optimum linking of R & D to production and marketing achieved?

E. How has the introduction of complex equipment and instrumentation affected the organization of R & D laboratories?

4. Planning and Management

A. How are corporate or government R & D goals or objectives established? What factors are involved? Who initiates? Who approves? Is there a clearly defined method? Are these established criteria?

B. How does project selection take place? Is this done subjectively, objectively, or by a combination of both? If an "intuitive" process is used, what, if any, are the identifiable elements?

C. Is it worthwhile to continue to compile and publish case histories and empirical studies based on observations; or should effort now be devoted to developing generalizations and theories based on extensive studies already available?

D. How much control of R & D effort is desirable? How can this best be achieved? What, if any, measurement methods can be discovered? How do various control procedures affect the behavior of R & D personnel?

E. What can be done to decrease the amount of non-productive effort in R & D organizations? What is a practical minimum amount of time spent in non-creative effort (writing up results of work, library studies, etc.), administrative work, education programs, etc.?

F. What are the principles, if any, that should guide the initiation and termination of R & D efforts? (Criteria for decision-making regarding R & D projects) When is an R & D project ready for commercial exploitation?

G. Can the effectiveness of R & D organizations be compared? Can an organization "achievement test" be devised? What qualities are essential in comparative evaluations?

H. How can rejuvenation of R & D organizations be effected? What is involved? What can be done to improve organization vitality?

I. How can assistants in laboratories (paper pushers, technicians, etc.) be used most effectively? How can younger workers best be "blended" with other more experienced persons? How can the occurrence of non-productive workers be minimized and how can they be salvaged? What is an optimum personnel turnover rate and how can it be achieved?

J. What is the "nature" of a productive R & D organization? How is the manager's attitude and "style" related to productivity? How can fundamental changes in work patterns be best effected?

5. Behavioral and Interpersonal Factors

A. How are personal attitudes of R & D personnel related to "orginizational" attitudes (esprit de corps, etc.)?

B. How can information be best "forced" through the "interfaces" which exist both within R & D organization and between the organization and the "outside?" What factors contribute toward the construction and destruction of "interfaces?"

C. What are optimum technical and non-technical communication patterns within R & D organizations?

D. What comprises technical communication and how does it take place. What information is necessary and how is it used? What is the optimum work balance between literature search, theoretical studies, and experimentation? What are the long-run effects of company secrecy policies?

E. What is the best size and physical arrangement of groups to assure the optimum communication of ideas and results?

6. Public Policy for Science and Technology

A. What is the contribution of R & D effort to the economy of the U. S., other countries, and society in general? How can it be measured? What are criteria by which success may be judged?

B. What proportion of resources of a society or segment of a society should be allocated to R & D?

C. How do inventions, innovations, and technological changes occur? What is their relationship to theoretical studies? What is their impact on particular firms, industries, and societies?

D. How can responsible public and corporate officials be made acquainted with technological developments, and the need for their encouragement and support?

E. Are there criteria by which responsible officials can distinguish between profitable and unprofitable R & D directions in allocating public or corporate funds? What are criteria for success in non-profit as well as profit-making enterprises?

F. What are the factors in society that influence inventions, innovations and technological changes?